Volume 21

Study AFS 44-6

STATE OF ALASKA

Jay S. Hammond, Governor

Annual Performance Report for

RUSSIAN RIVER SOCKEYE SALMON STUDY

by

David C. Nelson

ALASKA DEPARTMENT OF FISH AND GAME
Ronald O. Skoog, Commissioner

SPORT FISH DIVISION
Rupert E. Andrews, Director

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (CONT'D.)

LIST OF FIGURES

LIST OF FIGURES (CONT'D.)

Volume 20 Study No. AFS-44

RESEARCH PROJECT SEGMENT

State:	ALASKA	Name:	Sport Fish Investigations of Alaska
Project No.:	F-9-12		
Study No.:	AFS-44	Study Title:	ANADROMOUS FISH STUDIES
Job No.:	AFS-44-6	Job Title:	Russian River Sockeye Salmon Study

Period Covered: July 1, 1979 to June 30, 1980

ABSTRACT

Estimates at Lower Russian Lake Weir revealed the out-migration of sockeye salmon, Oncorhynchus nerka (Walbaum), smolts was 1,050,180. The peak of the migration (70.2 percent of the total) occurred during the 15-day period May 22-June 5. Age class 1.0 and 2.0 comprised 1.6 and 98.4 percent, respectively, of the out-migration. Average length of sockeye salmon smolts sampled was 97.3 millimeters.*

A creel census was conducted during the Russian River sockeye salmon sport fishery to determine harvest and effort. The census revealed 55,000 man-days of effort were expended to harvest 35,230 adult fish. Early and late runs contributed 8,400 and 26,830 salmon, respectively to this harvest. Due to a record late run adult return, an additional 640 meters (approximately 0.4 mile) was opened to sockeye salmon fishing above Russian River Falls on August 1. Anglers harvested 3,947 salmon (14.7 percent of the late run catch) from this area. Early and late run harvest rates were 0.087 and 0.188 salmon per angler hour, respectively. Anglers harvested 24.0 percent of the sockeye salmon which returned to Russian River in 1979.

Early run escapement was 19,700 sockeye salmon. This escapement is one of the largest recorded and exceeds the 16-year historical average escapement of 12,973 by 51.9 percent. Late run escapement enumerated at Russian River weir was 87,920. This is the highest escapement recorded since the inception of this program. An additional 3,920 late run fish spawned below Russian River Falls. Total late run 1979 escapement was therefore 91,840.

*Smolt enumeration at Russian River weir in 1979 was funded and conducted by the Division of Fisheries Rehabilitation Enhancement and Development Division (FRED). Results are reported here in the interest of research continuity associated with the Russian River drainage.

Management of the 1979 recreational sockeye salmon fishery was complicated by a larger than average early run, a record late run return and atypically low water which enabled both runs to move rapidly through the fishery. The management strategies employed to address this unique situation are presented and discussed.

Analysis of scales collected at Lower Russian Lake weir revealed both early and late runs were dominated by fish that resided two years in fresh water. Early run salmon were primarily three-ocean (79.1 percent) while the late run were primarily two-ocean (91.2) percent). These data are comparable to historic age structures. Average lengths of early and late run fish were 598.2 (23.5 inches) and 548.0 (21.6 inches) millimeters, respectively. Male to female sex ratio for the early run was 1:0.8 and for the late run 1:1.3. Length-frequency data for both runs are presented and discussed.

Fecundity investigations revealed early and late run sockeye salmon averaged 3,843 and 3,314 eggs per female, respectively. These averages are comparable to historical data.

In 1979 a fish passage facility was constructed at Russian River Falls. The facility was designed to permit fish unrestricted passage around the falls at periods of high water when their migration may be slowed or totally blocked by a velocity barrier. Use of this structure during the 1979 season is discussed.

Climatological data were again collected at Lower Russian Lake weir. Air and water temperature approximate historical data. Discharge rates through Russian River Falls during the early run approximated historical flows. During the latter part of the late run migration (August 17-22) Russian River Falls became a total barrier to sockeye salmon migration. Data indicate these high flow rates were due to heavy rain in the Upper Russian Lake drainage, rather than to precipitation in the Lower Russian Lake area.

BACKGROUND

Russian River is a clear stream adjacent to the Sterling Highway 9.6 km (6 mi) west of the Kenai Peninsula community of Cooper Landing and approximately 161 km (100 mi) south of Alaska's largest city, Anchorage. The stream is bordered on either side by Federally controlled lands. The area to the south is administered by the Kenai National Moose Range and on the north by the Chugach National Forest. A privately operated ferry at the confluence of the Kenai and Russian Rivers transports anglers to the south bank. This area (approximately 1.6 km or 1 mi) receives an average of 50% of all angler effort, as anglers attempt to intercept the runs prior to their entry into Russian River. The remaining effort occurs on the approximately 3.2 km (2 mi) of Russian River above the confluence area and below Russian River Falls. Public access is provided at the Kenai National

Moose Range campground at the confluence of the Kenai and Russian Rivers and at the Chugach National Forest campground located on Russian River. Figure 1 indicates the general location of Russian River as well as depicting the Russian River drainage in relation to the Kenai River and other pertinent land marks.

Sockeye salmon sport fishing is restricted to Lower Russian River from a marker 548 m (600 yds) below Russian River Falls to a marker 1,646 m (1,800 yds) below the Kenai and Russian River confluence, a total distance of approximately 4.8 km (3 mi). Lower Russian River and the confluence of the Kenai and Russian Rivers is commonly known as the "fly-fishing-only-area", and from June 1 through August 20, terminal gear is restricted to coho (streamer) flies with a gap between point and shank no greater than 9.5 mm (3/8 in). The area between a marker below the ferry crossing and a marker 640 m (700 yds) upstream on the Russian River is closed to all fishing from June 1 through July 14 to provide additional protection to early run sockeye salmon which concentrate in this area for a period of time before continuing their upstream migration (Figure 2). Sockeye salmon sport fishing is permitted in the Kenai River below the "fly-fishing-only-area" with conventional tackle. Harvest and effort are, however, minimal due to the glacial nature of the Kenai River.

Lower Russian River from its confluence with the Kenai River to a point approximately 3.2 km (2 mi) upstream is of moderate gradient. Upstream from this point the stream flows through a canyon of considerable gradient commonly known as Russian River Falls. During the previous 17 years, sockeye salmon have been delayed in the canyon on several occasions due to a velocity barrier caused by abnormally high water. Documented sockeye salmon mortalities associated with this barrier occurred in both 1971 and 1977 (Nelson, 1978). In 1971 the Sport Fish Division recommended construction of a fish passage facility to enable salmon to negotiate the Falls at high flows. The structure was built during the winter of 1978-79 and employed for the first time during the 1979 season.

Russian River sockeye salmon runs are bimodal, i.e., there are two distinct runs. Migrational timing, entry into the fishery and average run size has been previously discussed (Nelson, 1976 and 1977). Resident and anadromous fish species common to Russian River are presented in Table 1.

Lower Russian Lake, located 0.8 km (0.5 mi) above Russian River Falls, supports an active Dolly Varden and rainbow trout sport fishery. Physical characteristics of the lake have been previously described (Nelson, 1979). No early run sockeye salmon spawn in the lake or its tributaries. Observation suggests approximately 500 late run fish spawn in the shoal area (Nelson, 1979). This lake is utilized by rearing chinook and coho salmon.

Upper Russian River enters Lower Russian Lake from the south. This stream connects Upper and Lower Russian Lakes. Nelson (1976) has presented a

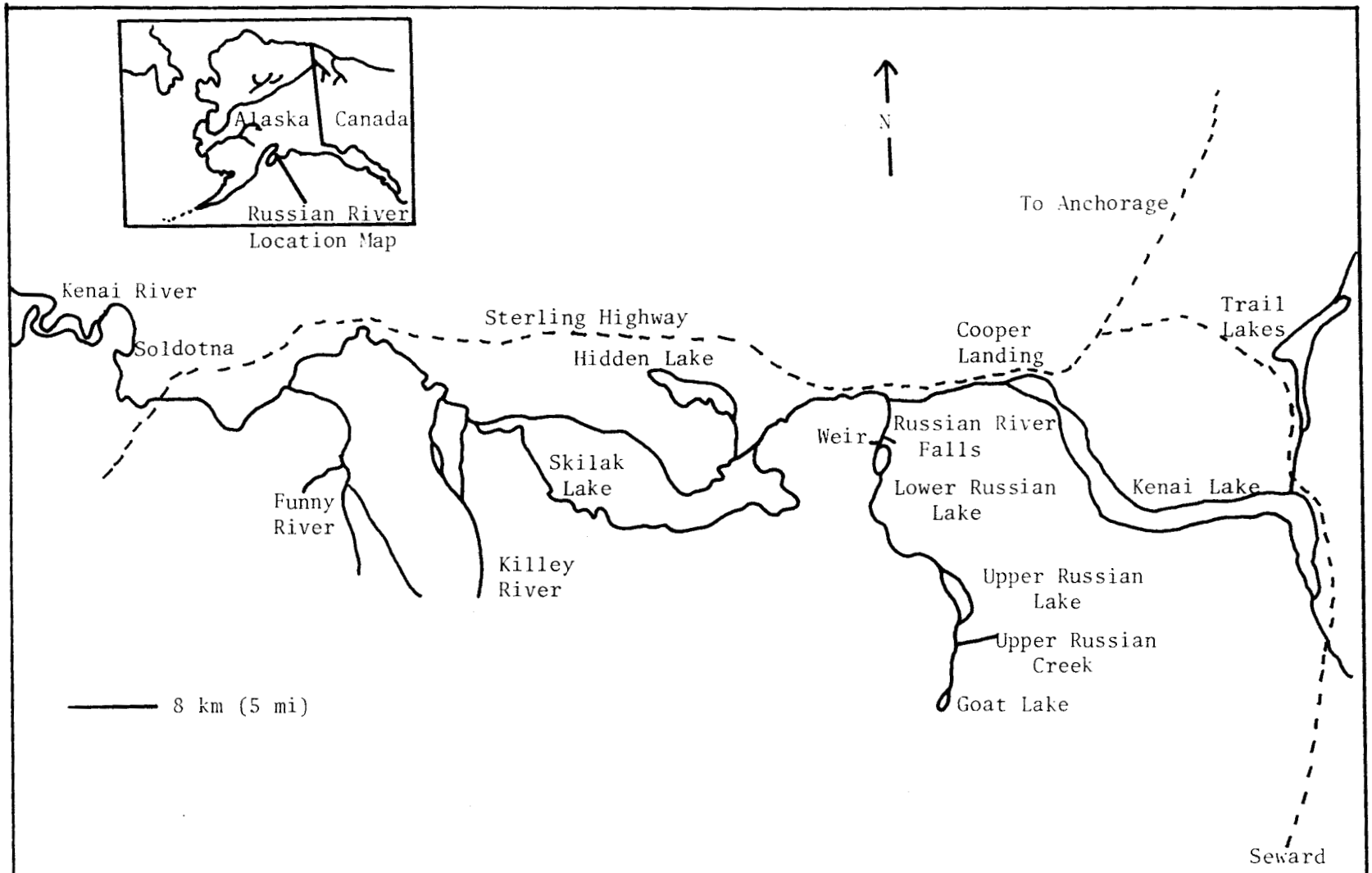


Fig 1. Schematic Diagram of the Kenai River Drainage.

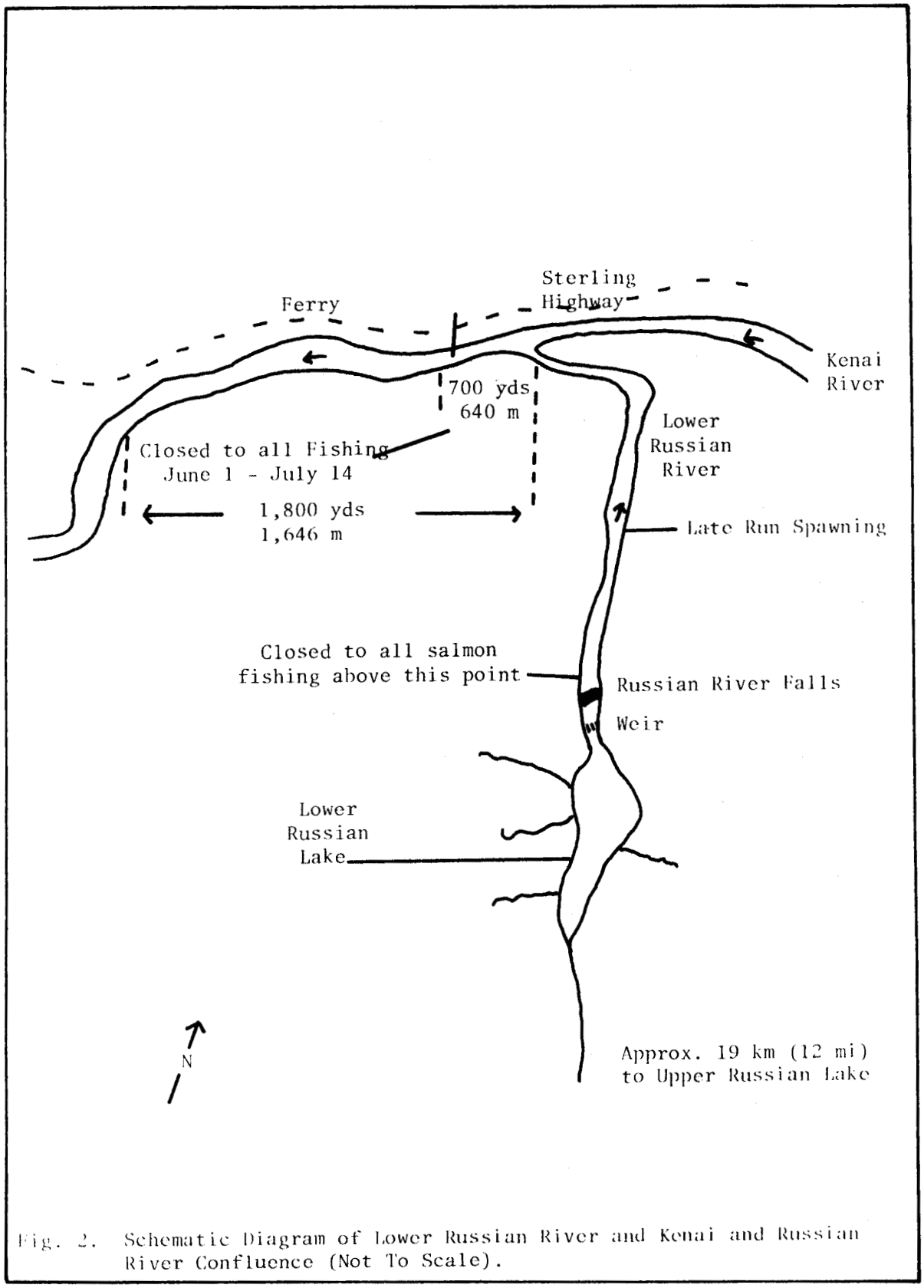


Fig. 2. Schematic Diagram of Lower Russian River and Kenai and Russian River Confluence (Not To Scale).

detailed description of this stream as well as Upper Russian Lake. Figure 3 is a schematic diagram of Upper Russian Lake depicting the known spawning areas of both early and late runs.

Management and research associated with the Russian River drainage has been conducted by the Sport Fish Division of the Alaska Department of Fish and Game since 1962. Prior information pertaining to this fishery has been presented by Lawler (1963, 1964), Engel (1965 through 1972) and Nelson (1973 through 1979).

To monitor angler effort and ascertain the recreational harvest of sockeye salmon, a creel census has been conducted since the inception of this project. In addition to seasonal harvest and effort the census provides catch per unit effort data which are employed for "in-season" management of the stocks. Further management information is obtained from exact enumeration of the spawning escapement, as fish pass through the weir located below Lower Russian Lake.

Regulatory measures affecting this fishery from 1960 through 1966 have been reviewed by Engel (1967). Regulatory changes from 1967 through 1975 have been presented by Nelson (1976). Basic regulation of the fishery has not been changed since 1975.

Despite an increasingly restrictive fishery, recreational demands upon the Russian River sockeye salmon resource has at times been greater than the stocks can sustain. This is evidenced in that the Sport Fish Division has closed all or part of the fishery on 17 different occasions since 1969. One emergency closure was required for management purposes in 1979. Extensive emergency openings and closings of this system indicate that it is probably the most intensely managed sport fishery in Alaska.

The Russian River management program is currently directed towards "in-season" evaluation of stock status to evaluate the effects and effectiveness of current regulatory practices. Research activities presently emphasize the collection and evaluation of life history data. Objectives include determination of optimum escapement goals for both runs and ultimately, predictions of sockeye salmon returns to Russian River. The latter objective can not be realized until stock separation techniques are perfected in Cook Inlet to determine the late run Russian River sockeye salmon's contribution to the commercial fishery.

RECOMMENDATIONS

1. The feasibility of stabilizing the flow of Upper Russian Creek during the early run's spawning and egg incubation period should be investigated. Data indicate large numbers of eggs were washed from this stream by high water in 1976 and 1977. Egg loss from high water will adversely affect the number of returning adults.

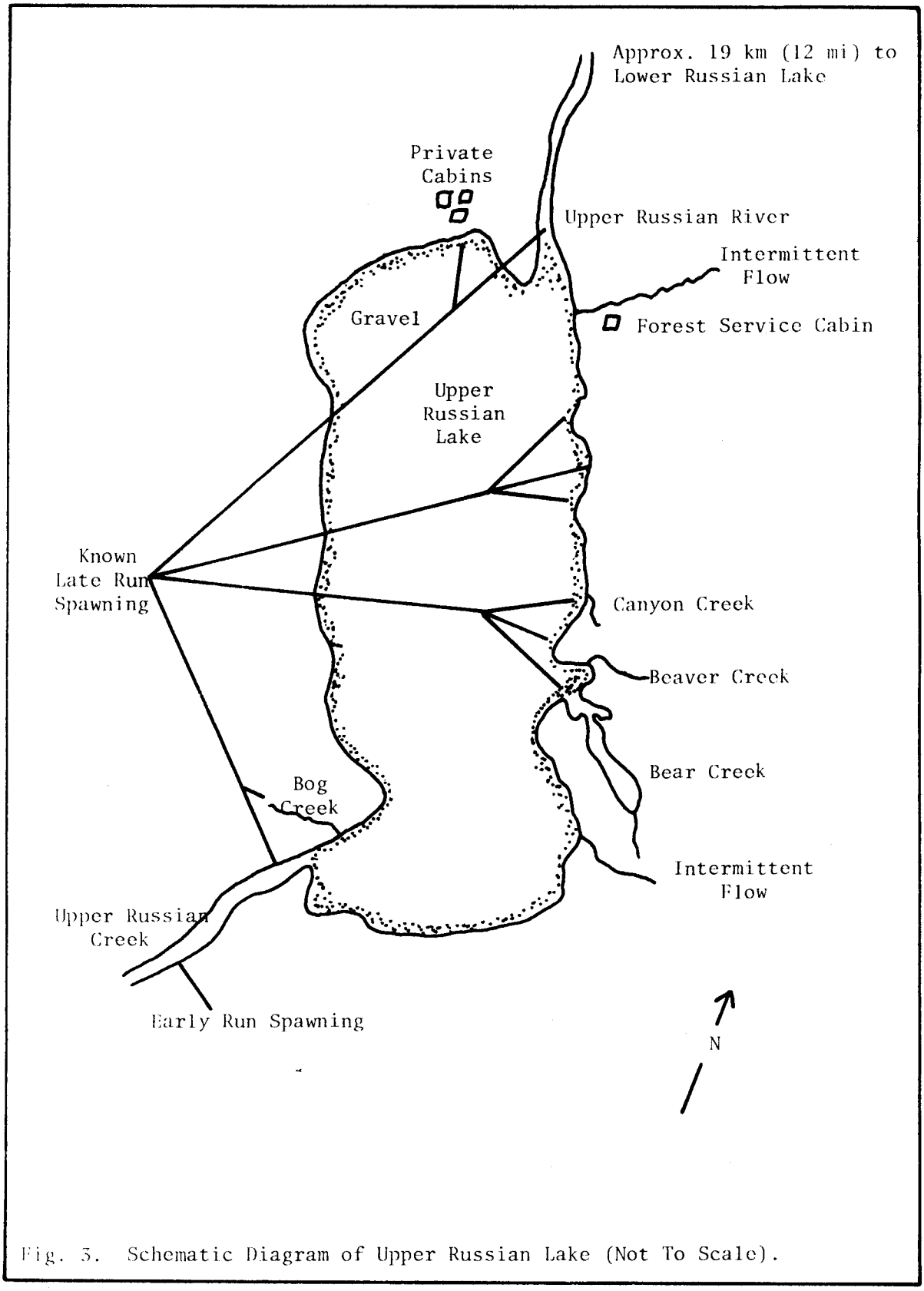


Fig. 3. Schematic Diagram of Upper Russian Lake (Not To Scale).

Table 1. A List of Common Names, Scientific Names and Abbreviations of Fish Species Found in Russian River Drainage.

Common Name	Scientific Name and Author	Abbreviation
Sockeye salmon	*Oncorhynchus nerka* (Walbaum)	RS
Chinook salmon	*Oncorhynchus tshawytscha* (Walbaum)	KS
Coho salmon	*Oncorhynchus kisutch* (Walbaum)	SS
Pink salmon	*Oncorhynchus gorbuscha* (Walbaum)	PS
Dolly Varden	*Salvelinus malma* (Walbaum)	DV
Rainbow trout	*Salmo gairdneri* Richardson	RT
Slimy sculpin	*Cottus cognatus* Richardson	SSC

2. The present objectives of the Russian River Sockeye Salmon Study should be continued.

OBJECTIVES

1. To determine adult harvest of sport caught early and late run Russian River sockeye salmon in Russian River drainage.

2. To collect and analyze biological data concerning abundance and migrational timing of adult sockeye salmon in the Russian River drainage.

3. To determine age composition of adult early and late run Russian River sockeye salmon escapements enumerated at Lower Russian Lake Weir.

4. To determine egg deposition of early and late run spawning sockeye salmon in two major tributaries of Upper Russian Lake, i.e. Upper Russian and Bear Creeks.

5. To determine fecundity of early and late run Russian River female sockeye salmon and to determine the relationship (if any) between fish length and average number of eggs per sockeye salmon female.

6. To collect basic climatological data (precipitation, water and air temperature, stream discharge) at Lower Russian Lake and to determine if a relationship exists between these parameters and migrational timing.

7. To evaluate the effects and effectiveness of a fish pass at Russian River Falls.

8. To evaluate current regulations governing this sport fishery and to provide recommendations for future management and research.

TECHNIQUES USED

The 1979 Russian River creel census was a modification of the technique described by Neuhold and Lu (1957). Sampling procedures and calculations were identical to those outlined by Engel (1965, 1970, 1972) and Nelson (1973, 1975).

Adult escapements were enumerated by weir at the outlet of Lower Russian Lake. The present weir was constructed in June 1975 and replaced a temporary weir (described by Engel, 1970) which had been in use since 1969. Nelson (1976) has presented a detailed description of the present structure. In May 1978 the existing adult weir was modified by the Division of Fisheries Rehabilitation and Enhancement (FRED) to enumerate smolts. These modifications have been previously described (Nelson, 1979).

In 1978 a stratified random sampling scheme was designed to estimate the out-migration of sockeye, coho and chinook salmon smolts. In 1979 an aperture sonar counter manufactured by Bendix Corporation was employed. The counter was operational on a 24 hour basis with calibrations checked six times daily. Analysis of sonar counts to actual number of smolts visually enumerated indicated the counter recorded an average of one count for each 3.75 smolt which passed through the aperture. Daily counts were therefore increased by this figure. Total out-migration was determined by summing the daily counts. Species composition was determined by random sampling.

Average fecundity of early and late run sockeye salmon was determined by sampling at Lower Russian Lake Weir. The sampling technique employed has been described (Nelson, 1979).

Scale samples to determine the age structure and sex ratios for early and late runs were collected at Lower Russian Lake weir. Age designation, number of fish sampled, and methods employed to determine the adult age structure and male to female sex ratio have been previously presented (Nelson, 1978).

Water and air temperatures at Lower Russian Lake were determined by a Taylor maximum-minimum thermometer. Precipitation was determined by a gauge of standard manufacture. Stream velocity was determined by the Head Rod method as described by Nelson (1977).

In 1979 a fish pass was constructed around Russian River Falls. The facility was constructed on the south bank on lands administered by the Kenai National Moose Range. The fish pass consisted of a tunnel, 73 m (240 ft) in length, 2.7 m (9 ft) in height and 2.4 m (8 ft) in width. The entrance was a 51.2 m (50 ft) chute constructed of a 20.3 cm (8 in) x 20.3 cm (8 in) timbers which extended to a pool at the base of the Falls. The chute was covered with a steel grate. A pool and weir type fish ladder was created in the chute by installing five series of timbers approximately 3.0 m (10 ft) apart. The tunnel contained 28 vertical slots to reduce flow and provide resting areas. The vertical drop from inlet to outlet was 8.2 m (27 ft). Water flow was controlled by stop logs at the head of the tunnel. The fish pass was constructed by Cooper Construction Company of Anchorage, Alaska at a cost of $726,800. Detailed plans of the Russian River Fish Pass are on file at the Division of Fisheries Rehabilitation and Enhancement (FRED) Office of Engineering.

FINDINGS

Smolt Investigations

In 1979 the smolt weir at Lower Russian Lake was operational May 4. The first sockeye salmon smolts were enumerated on May 15, 2 days earlier

than in 1978. Water temperature at the onset of the out-migration was 5.9°C (42.6°F). Estimates revealed the total out-migration was 1,050,180 sockeye salmon smolts. Numbers of smolts enumerated in 1979 were therefore 26.5% above the 1978 estimate of 829,980. Table 2 summarizes the 1979 sockeye salmon smolts out-migration by 5 day periods.

This table indicates that 70.2% of the 1979 total out-migration occurred during the 15-day period May 22 through June 5. In 1978 the smolts migrated at a more rapid rate, as 75.3% of that year's out-migration occurred during the 5-day period of May 22 through 26. Additional data must be collected to determine whether or not this variation is related to external parameters (water temperature, precipitation, etc.).

The smolt weir was removed on July 10 when the water temperature was 12.4°C (54.3°F). Foerster (1968) indicates that the out-migration of sockeye salmon smolts terminates when the water temperature approximates 13°C (55.4°F). Burgner (1958) reported that sockeye salmon smolts ceased migration at a temperature of 10°C (50°F) at Lake Aleknagik in Alaska's Wood River system. In 1978 only 0.3% of the Russian River out-migration was enumerated after the water temperature reached 12.2°C (54°F). It is therefore assumed that virtually all out-migration had ceased in the Russian River by July 10, 1979.

Average length and weight of all sockeye salmon smolts sampled in 1979 was 97.3 mm (3.8 in) and 6.9 g (0.2 oz). Smolts in 1979 were therefore 7.4 mm (0.3 in) larger and 0.9 g (0.03 oz) heavier than were those sampled in 1978. Age class 2.0 dominated the out-migration, contributing 98.4% to the total. These fish averaged 96.8 mm (3.8 in) in length and 6.7 g (0.2 oz) in weight. Tables 3 and 4 summarize the Russian River sockeye salmon smolt age and length data collected in 1979.

Table 3 presents the lengths and weights for age 2.0 and 3.0 fish. These average lengths and weights are within the ranges as reported by Foerster (1968) for other sockeye salmon systems. Table 4 reveals that the majority of the 1979 out-migration were the progeny of the 1976 spawning escapement. Techniques are not presently available to separate early and late run smolts. The respective contributions of the early and late run 1976 escapement to the 1979 total smolt out-migration can therefore not be estimated.

Creel Census

A creel census conducted from June 9 through August 20 on Russian River indicated anglers expended 55,000 man-days of effort or 215,217 angler hours in 1979. Effort directed toward early and late run stocks was estimated to be 25,670 and 29,330 man-days, respectively.

Based on interviews with 4,150 anglers who reported harvesting 2,562 sockeye salmon, total catch was estimated at 35,230 salmon. Early and

Table 2. Estimated Outmigration of Russian River Sockeye Salmon Smolts by Five-Day Period, 1979.

Five-Day Period	Water Temperature* °C	°F	Sockeye Salmon Smolt	Percent of Outmigration
May 15 - 21**	5.9	42.6	75,465	7.2
May 22 - 26	6.8	44.3	339,579	32.3
May 27 - 31	9.3	48.8	195,069	18.6
June 1 - 5	8.7	47.7	202,203	19.3
June 6 - 10	9.9	49.8	125,675	12.0
June 11 - 15	9.4	48.9	45,471	4.3
June 16 - 20	10.0	49.9	16,698	1.6
June 21 - 25	10.7	51.2	18,247	1.7
June 26 - 30	10.3	50.5	6,648	0.6
July 1 - 5	12.1	53.9	10,074	1.0
July 6 - 10	12.4	54.3	15,051	1.4
Total			1,050,180	100.0

* Temperature is the average of the daily recordings for that period.
** Seven-day period.

Table 3. Summary of Russian River Sockeye Salmon Smolts Age, Length and Weight Data Collected at Russian River Weir, 1979.

Age Class	Number Sampled	Percent of Migration	Average Length (mm)	S.D.*	Average Weight (g)	S.D.*
2.0	911	98.4	96.8	5.6	6.7	2.7
3.0	15	1.6	126.1	15.7	17.0	6.5
Combined	926	100.0	97.3**	6.8	6.9**	3.2

* Standard Deviation.
** Mean length and weight of 926 smolts sampled.

Table 4. Age Class Composition, Sample Size, Parent Year and Parent Year Escapement of Russian River Sockeye Salmon Smolts Sampled at Lower Russian Lake Weir, 1979.

Age Class	Number Sampled	Estimated Number in the Out-migration	Parent Year	Parent Year Escapement*
2.0	911	1,033,377	1976	46,650
3.0	15	16,803	1975	37,610
Combined	926	1,050,180		84,260

* Sum of early and late run escapements.

late runs contributed 8,400 and 26,830 fish, respectively to this harvest. Mean hourly catch rates were higher on weekdays (0.158) than on weekend days (0.117), due to greater congestion during weekend periods which reduced angler efficiency. Seasonal catch per hour was 0.136. Harvest, effort and catch per hour estimates since 1963 are summarized in Table 5.

Total weekday and weekend stream counts during the 1979 fishery averaged 190.6 and 276.8 anglers, respectively. These data indicate that the average number of anglers on the stream in 1979 was second only to the record years of 1977 and 1978 (Table 6). The high individual angler count was on August 4 at 0800 when 721 anglers were fishing in the traditional "fly-only-area" and an additional 89 were enumerated in the area above Russian River Falls opened by emergency order on August 1.

Each angler fished an average of 3.8 hours on weekdays and 3.9 hours on weekends. These data represent a decrease in average hours fished in relation to historical data (Table 6). Although the reason(s) for the decreased time the average angler spent on the stream in 1979 is not definitely known, it may be related to run size (Nelson, 1979). Large returns of Russian River sockeye salmon occurred in 1972, 1977, 1978 and again in 1979. Average hours fished per angler per day during these years were less than the historical average.

Stream counts revealed 60.6 and 49.7% of the anglers enumerated during total stream counts fished the confluence area of the Kenai and Russian Rivers during the early and late runs, respectively. The probable reason why anglers favored the confluence area during the early run is that the 640 m (700 yd) closed area was opened by emergency order on June 28. Anglers therefore concentrated in this area to harvest sockeye salmon which were highly visible. The late run was the largest recorded at Russian River. Fishing was considered good to excellent in all areas. Anglers therefore distributed themselves throughout the entire "fly-fishing-only-area".

On August 1, 1979 an additional 640 m (0.4 mi) was opened to the taking of sockeye salmon above Russian River Falls. Creel census data revealed harvest and effort in this area was 3,947 salmon by 2,623 man-days of effort. The area therefore contributed 14.7% to the total late run harvest and accounted for 8.9% of the late run effort.

Anglers harvested 29.9% of the early run stocks which returned to Russian River and 23.4% of the late. These exploitation rates are relatively low in relation to the high return of early and late run fish. Angler opportunity was also increased by the opening of the "sanctuary" area on June 28 and the additional opening above the Russian River Falls on August 1. The probable explanation for the low harvest rate is that Russian River discharge was atypically low during most of the early and late run's migration. Low water appears to have accentuated the migrational speed of the runs and reduced the time they were subject to capture by the sport fishermen.

Table 5. Estimated Sockeye Salmon Harvest, Effort and Success Rates On Russian River, 1963-1979.

Year	Harvest			Total Effort (Man-Days)	Catch/ Hour	Census Period
	Early Run	Late Run	Total			
1963	3,670	1,390	5,060	7,880	0.190	6/08-8/15
1964	3,550	2,450	6,000	5,330	0.321	6/20-8/16
1965	10,030	2,160	12,190	9,720	0.265	6/15-8/15
1966	14,950	7,290	22,240	18,280	0.242	6/15-8/15
1967	7,240	5,720	12,960	16,960	0.141	6/10-8/15
1968	6,920	5,820	12,740	17,280	0.134	6/10-8/15
1969	5,870	1,150	7,020	14,930	0.094	6/07-8/15
1970	5,750	600	6,350	10,700	0.124	6/11-8/15*
1971	2,810	10,730	13,540	15,120	0.192	6/17-8/30*
1972	5,040	16,050	21,090	25,700	0.195	6/17-8/21
1973	6,740	8,930	15,670	30,690	0.102	6/08-8/19*
1974	6,440	8,500	14,940	21,120	0.131	6/08-7/30*
1975	1,400	8,390	9,790	16,510	0.140	6/14-8/13*
1976	3,380	13,700	17,080	26,310	0.163	6/12-8/23*
1977	20,400	27,440	47,840	69,510	0.168	6/18-8/17
1978	37,720	24,530	62,250	69,860	0.203	6/07-8/09
1979	8,400	26,830	35,230	55,000	0.136	6/09-8/20*
1963-78 Average	8,869	9,053	17,923	23,494	0.175	

* Census period was not continuous during these years due to emergency closures required to increase escapement levels.

Table 6. Differences Between Weekday and Weekend Day Fishing Pressure and Rates of Success at Russian River, 1964-1979.

Year	Average Angler Counts		Catch/Hour		Average Hours Fished	
	Week-days	Weekend Days	Week-days	Weekend Days	Week-days	Weekend Days
1964	29.6	70.6	0.444	0.209	3.3	3.9
1965	31.7	78.1	0.305	0.223	4.5	5.4
1966	53.2	143.1	0.297	0.183	4.8	5.5
1967	68.9	110.5	0.171	0.100	5.3	5.4
1968	71.5	124.9	0.153	0.107	5.3	5.8
1969	64.5	111.7	0.110	0.074	4.9	5.1
1970	83.5	127.8	0.140	0.100	4.8	4.7
1971	87.9	157.2	0.194	0.189	4.8	5.3
1972	73.3	138.5	0.203	0.187	4.0	4.4
1973	147.1	195.0	0.113	0.088	4.8	5.5
1974	123.8	144.4	0.164	0.085	4.7	5.7
1975	65.0	149.6	0.145	0.136	4.5	5.1
1976	72.5	134.4	0.165	0.161	3.5	4.5
1977	201.7	438.6	0.172	0.164	3.9	4.3
1978	264.1	425.7	0.205	0.191	3.9	4.2
1979	190.6	276.8	0.158	0.117	3.8	3.9
1964-78 Average	95.9	170.0	0.199	0.146	4.5	5.0

Nelson (1976) reviewed angler participation trends and indicated angler effort would continue to shift from the smaller early run to the more numerous late run stocks. Table 7 indicates that these trends did not develop as anticipated as from 1977 through 1979; 58.7% of all angler effort was directed toward early run fish. The average early run total return (harvest + escapement) during these years was 45,480, or more than twice the historical average return of 21,830. It is therefore evident that angler effort in a given year will be directed toward the more numerous stock, rather than toward the early or late run per se.

During the census 75 Dolly Varden, 30 rainbow trout, and 15 coho salmon were creel checked. These data were expanded revealing a total incidental harvest of 1,010 Dolly Varden, 400 rainbow trout and 180 coho salmon. The latter figure is a minimum estimate, as the peak of this species migration in the Russian River is from approximately July 20 through September 1. The creel census terminated August 20. Two round whitefish, Prosopium cylindraceum, were creel checked at the ferry crossing on the Kenai River. These fish are not indigenous to the Russian River drainage. Total harvest of these fish from that portion of the "fly-fishing-only-area" of the Kenai River is estimated at 15.

Escapement

Russian River weir was operational May 4. The first early run sockeye salmon adult passed on June 8, 10 days earlier than the historical average date of June 18. Fifty percent of the early run had passed the weir by June 27. Early run passage was complete by July 15 (Table 8).

Early run escapement was 19,700. This is one of the highest escapements recorded for this segment of the population and exceeds the historic average escapement of 12,973 by 51.9%. Larger early run escapements were recorded only in 1965 and 1978 (Table 9).

The first late run fish arrived at the weir on July 16. Fifty percent of this run had passed the weir by July 29. The migration was basically complete by September 2. Escapement of late run fish above Russian River Falls was 87,920. This is the largest escapement recorded for this segment of the population, exceeding the historical average late run escapement of 38,274 by 129.7%. The previous high escapement was 79,000 in 1972. An additional 3,920 fish spawned below Russian River Falls. Total late run escapement in 1979 was therefore a record 91,840. Late run escapements and total return to Russian River are summarized in Table 10.

Chinook salmon escapement through Russian River weir in 1979 was 280. This is the highest escapement of this species enumerated at the weir. An additional 82 fish were observed spawning below Russian River Falls. Total chinook salmon escapement to Russian River in 1979 was 362. This is the second highest escapement recorded. Coho salmon escapement was 2,400.

Table 7. Angler Effort Directed Toward Early and Late Run Russian River Sockeye Salmon Stocks, 1963-1979.

Year	Effort (Man-Days)*		Effort (Percent)	
	Early Run	Late Run	Early Run	Late Run
1963	5,710	2,170	72.5	27.5
1964	3,980	1,350	74.7	25.3
1965	7,750	1,970	79.7	20.3
1966	11,970	6,310	65.5	34.5
1967	11,460	5,500	67.6	32.4
1968	11,780	5,500	68.2	31.8
1969	12,290	2,640	82.3	17.7
1970	9,700	1,000	90.7	9.3
1971	6,250	8,870	41.3	58.7
1972	12,340	13,360	48.0	52.0
1973	15,220	15,470	49.6	50.4
1974	11,090	10,030	52.5	47.5
1975	5,210	11,300	31.5	68.5
1976	8,930	17,380	33.9	66.1
1977	38,200	31,310	55.0	45.0
1978	51,910	17,950	74.3	25.7
1979	25,670	29,330	46.7	53.3
1963-78 Average	13,987	9,507	61.7	38.3

* Man-day is defined as one angler fishing for one day irrespective of the amount of time fished.

Table 8. Arrival Date, Dates Fifty Percent of the Escapement Passed Russian River Weir/Counting Tower and Termination Dates of Early and Late Russian River Sockeye Salmon Runs, 1960-79.*

	Early Run			Late Run		
Year	Arrival At Weir/ Counting Tower	Date 50% Passed	Date Run Ended	Arrival At Weir/ Counting Tower	Date 50% Passed	Date Run Ended**
1960	June 19	June 26	July 15	July 16	August 1	August 12
1961	June 21	June 28	July 15	July 16	July 31	August 28
1962	June 18	July 4	July 15	July 16	July 30	August 31
1963	June 18	July 1	July 12	July 16	July 31	August 23
1964	June 20	July 7	July 15	July 16	July 30	August 15
1965	June 22	July 4	July 15	July 16	August 5	August 15
1966	June 20	June 29	July 15	July 16	July 30	August 17
1967	June 20	June 28	July 15	July 16	August 2	August 18
1968	June 25	June 29	July 13	July 19	July 31	August 14
1969	N O D A T A A V A I L A B L E			July 16	August 2	August 18
1970	June 17	July 5	July 15	July 16	August 7	August 23
1972	June 24	July 5	July 29	July 30	August 5	August 28
1973	June 21	July 6	July 15	July 16	August 1	August 30
1974	June 14	July 1	July 21	July 22	August 7	August 27
1975	June 25	July 6	July 27	July 21	August 6	September 1
1976	June 17	June 30	July 16	July 17	August 2	September 1
1978	June 10	July 2	July 24	July 2	July 30	September 1
1979	June 8	June 27	July 15	July 16	July 29	September 2
1960-78 Average	June 19	July 2	July 17	July 17	August 4	August 23
1969-78*** Average	June 18	July 4	July 21	July 18	August 6	August 28

* 1971 and 1977 data were deleted due to a velocity barrier at Russian River Falls which resulted in atypical migrational timing.

** Date run ended and/or counting tower or weir count terminated.

*** Years of weir operation.

Table 9. Russian River Sockeye Salmon Escapement Estimates and Harvest Rates for Early and Late Runs, 1963-1979.

Year	Escapement*			Percentage of Run Caught by the Sport Fishery*		
	Early Run	Late Run	Total	Early Run	Late Run	Combined
1963	14,380	51,120	65,500	20.3	2.0	7.2
1964	12,700	46,930	59,630	21.8	5.0	9.6
1965	21,710	21,820	43,330	31.8	9.0	21.6
1966	16,660	34,430	51,090	47.3	17.5	30.3
1967	13,710	49,480	63,190	34.6	10.3	17.0
1968	9,200	48,880	58,080	42.9	10.6	18.0
1969	5,000**	28,920	33,920	54.0	3.8	17.1
1970	5,450	28,200	33,650	51.3	2.1	15.9
1971	2,650	54,430	57,080	51.5	16.4	19.2
1972	9,270	79,000	88,270	35.2	16.8	19.3
1973	13,120	24,970	38,090	33.9	26.3	29.1
1974	13,150	24,650	37,800	32.9	25.6	28.3
1975	5,640	31,970	37,610	19.9	20.8	20.7
1976	14,700	31,950	46,650	18.7	30.0	26.8
1977	16,070	21,410	37,480	55.9	56.2	56.1
1978	34,150	34,230	68,380	52.5	41.7	47.7
1979	19,700	87,920	107,620	29.9	23.4	24.7
1963-79 Average	12,973	38,274	51,234	37.8	18.4	24.0

* Escapement passed weir. Commercial harvest and fish spawning downstream from Russian River weir are deleted.

** Escapement determined by foot survey of Upper Russian Creek.

Table 10. Late Run Russian River Sockeye Salmon Total Return and Escapement Enumerated Both above and below Russian River Falls, 1968-1979.

Year	Escapement Above Falls	Escapement Below Falls	Total Escapement	Percent of Escapement Below Falls	Sport Harvest	Total Return
1968	48,800	4,200	53,000	7.9	5,820	58,820
1969	28,920	1,100	30,020	3.7	1,150	31,170
1970	28,200	220	28,420	0.8	600	29,020
1971	54,430	10,000	64,430	15.5	10,730	75,160
1972	79,000	6,000	85,000	7.1	16,050	101,050
1973	24,970	6,690	31,660	21.1	8,930	40,590
1974	24,650	2,210	26,860	8.2	8,500	35,360
1975	31,970	690	32,660	2.1	8,390	41,050
1976	31,950	3,470	35,420	9.8	13,700	49,120
1977	21,410	17,090	38,500	44.4	27,440	65,940
1978	34,230	18,330	52,560	34.9	24,530	77,090
1979	87,920	3,920	91,840	4.3	26,830	118,670
1968-1978 Average	37,139	6,364	43,503	14.1	11,440	54,943

This is the sixth consecutive year escapement of this species has exceeded the historical average escapement of 1,349. Historical chinook and coho salmon escapements are summarized in Table 11.

Relationship of Jacks to Adults

The early Russian River sockeye salmon run is usually devoid of jacks (precocial males). Nelson (1979) noted jacks have been observed in the early run during only 3 of 9 years of weir operation. Four jacks were enumerated in 1979. Jacks are more numerous during the late run comprising between 0.2 and 8.8% of the escapement (Table 12).

As suggested by Nelson (1977) a relationship may exist between numbers of jacks in a given year and the magnitude of the late run return the succeeding year. The average jack return in 1969, 1972, 1973 and 1977 was only 345. The average return in the succeeding years was 38,653 or 19.4% below the historical average. Jack returns for 1970, 1971, 1974 1975, 1976 and 1978 averaged 1,808. The average return in the succeeding years was 72,194. A relatively small number of jacks in a given year may therefore indicate a less than average return the following year. The converse also appears to be true.

It is also of interest to note the migrational timing of jacks compared to late run adult sockeye salmon. Historical data reveals 50% of the adult escapement may be expected to pass the weir at Lower Russian Lake by August 4. Fifty percent of the jack escapement is not historically enumerated at the weir until August 13, 10 days later than the adults. In 1979 the disparity between migrational timing of adults and jacks was 17 days (Table 13).

It is not known whether this timing differential is a racial characteristic, related to physical factors, or is a combination thereof. Nelson (1976) indicated water levels generally decrease during the latter part of the late run's migration and may facilitate the jack's movement through the Falls. Larger adults may be more readily capable of ascending the Falls at greater water velocities and therefore arrive earlier at the weir.

Migrational Timing in the Kenai River

Data regarding migrational timing of Russian River stocks within the mainstem Kenai River are limited to isolated tagging studies and a comparison of sonar counts to escapements enumerated at Russian River weir. Results of the tagging studies have been previously reviewed (Nelson, 1977).

The sonar counter, located approximately 1.6 km (1 mi) below the Kenai River bridge in Soldotna is operated by the Commercial Fish Division of the Alaska Department of Fish and Game. The counter is usually operational

Table 11. Coho and Chinook Salmon Escapements in the Russian River Drainage, 1953-1979.

Year	Weir/Counting Tower Escapement		Lower River	Total Escapement	
	Chinook	Coho	Chinook Escapement*	Chinook	Coho
1953			85**		
1954			87**		
1955			42**		
1956			40**		
1957			44**		
1958			98**		
1966			182		
1967			26		
1968	56		63	119	
1969	119	70	31	150	70
1970	240	957	125	365	957
1971	21	839	149	170	839
1972	172	666	108	280	666
1973	243	200	104	347	200
1974	124	1,508	59	183	1,508
1975	102	4,000	32	134	4,000
1976	145	1 791	155	300	1,791
1977	37	1,884	145	182	1,884
1978	253	1,570	165	418	1,570
1979	280	2,400	82	362	2,400
Average through 1978	137	1,349	91	241	1,349

* Coho salmon do not spawn in Lower Russian River.
** Fish and Wildlife Service surveys.

Table 12. Late Run Russian River Sockeye Salmon Harvest, Escapement and Returning Jacks, 1969-1979.

Year	Escapement	Harvest	Total Return*	Number of Jacks	Percent of Total Return
1969	28,920	1,150	30,070	352	1.2
1970	28,200	600	28,800	2,542	8.8
1971	54,430	10,730	65,160**	1,429	2.2
1972	79,000	16,050	95,050	160	0.2
1973	24,970	8,930	33,900	332	1.0
1974	24,650	8,500	33,150	1,008	3.0
1975	31,970	8,390	40,360	1,788	4.4
1976	31,950	13,700	45,650	1,204	2.6
1977	21,410	27,440	48,850	537	1.1
1978	34,230	24,530	58,760	2,874	4.9
1979	87,920	26,830	114,750	1,476	1.3
1969-78 Average	35,973	12,002	47,975	1,223	2.9

* Excludes commercial harvest and late run sockeye salmon spawning below Russian River Falls.

** Excludes an estimated 10,000 late run sockeye salmon which perished below Russian River Falls due to a velocity barrier.

Table 13. Migrational Timing of the Late Run Russian River Sockeye Salmon Jack Escapement Compared to the Migrational Timing of the Adult Escapement, 1970-1979.*

Year	Jack Escapement	Date 50% Passed Weir	Adult Escapement**	Date 50% Passed Weir	Timing Differential (Days)
1970	2,542	8/10	25,658	8/7	4
1972	160	8/10	78,677	8/4	7
1973	332	8/6	24,642	7/31	7
1974	1,008	8/12	23,639	8/6	7
1975	1,788	8/16	30,179	8/5	12
1976	1,204	8/18	30,746	8/2	16
1978	2,874	8/18	31,356	8/2	16
1979	1,476	8/15	87,920	7/29	17
1970-78 Average	1,415	8/13	34,985	8/4	10

* 1971 and 1977 data have been deleted due to atypical migrational timing resulting from a velocity barrier at Russian River Falls.

** Escapement passed the weir only. Fish spawning below the Falls are not included.

only during the late run. In 1978 and 1979, however, the counter was operational during the early Kenai River sockeye salmon migration. All available data indicate the majority of early run Kenai River sockeye salmon are of Russian River origin.

Nelson (1979) reported that in 1978 it required early run fish 29 days to traverse the 93.5 km (58 mi) between sonar counter and the Russian River weir. Rate of travel was therefore an average of 3.2 km (2 mi) per day. In 1979, 50% of the early run was enumerated by the sonar/counter on June 7 and 50% of the early run Russian River escapement had passed the weir by June 27. Travel time was therefore 20 days in 1979 or 4.6 km (2.9 mi) daily.

Sonar counts, Russian River escapements and time of travel between sonar counter and the Russian River weir for late run Russian River fish are presented in Table 14. This table indicates that the elapsed time between sonar site and weir from 1968 to 1978 ranged from 11 to 34 days, averaging 16. Eliminating the 1969 and 1974 extremes, the migrational period in the mainstem Kenai River for these fish ranged from 10 to 13 days, averaging 12. Migrational time in 1979 was 10 days or 9.3 km (5.8 mi) per day.

Evaluation of sonar data and magnitude of the total Russian River late run does provide an estimate of the Russian River's contribution to the Kenai River sockeye salmon escapement. Data indicate the Russian River's contribution has ranged from 8.7% to 66.9%, averaging 30.5%. This system's contribution in 1979 was 36.9%. This is the largest percentage of the Kenai River escapement to enter Russian River since 1970 (Table 15).

Management of the 1979 Fishery

Early run sockeye salmon entered the Russian River sport fishery on June 9. Analysis of creel census data collected from this date through July 26 indicated relatively low catch rates. Conversely, escapement levels at the Russian River weir were above average for this time period and indicated a relatively strong early run was in progress. Observations by the author indicated salmon were remaining in the closed or "sanctuary" area at the confluence of the Kenai and Russian Rivers for a period of time and then traversing the remaining 3.2 km (2 mi) through the fishery during the hours of darkness. The affect of the early run's atypical migration pattern was to reduce the time and numbers of fish available to recreational anglers despite the higher than average return of this stock.

In response to this unique situation, the Division of Sport Fish opened the "sanctuary" area on June 28 to permit the harvest of fish heretofore protected by this 640 m (700 yd) area. Anglers immediately took advantage of this additional opening; by June 30 up to 400 anglers per hour were enumerated at the confluence of the Kenai and Russian Rivers. The early run migration was complete by July 10.

Table 14. Kenai River Sonar Counts Compared to Russian River Late Run Sockeye Salmon Escapements and Period of Travel Between Sonar Site and Russian River Weir, 1968-1979.*

Year	Sonar Count	Date 50% Passed	Russian River Escapement**	Date 50% Passed	Sonar to Weir (Days)
1968	88,000	7/19	48,800	7/30	11
1969	53,000	6/30	28,920	8/ 2	34
1970	68,000	7/25	28,200	8/ 6	13
1972	335,000	7/24	79,000	8/ 4	12
1973	368,000	7/22	24,970	7/31	10
1974	157,000	7/17	24,650	8/ 6	23
1975	143,000	7/24	31,970	8/ 5	13
1976	381,000	7/20	31,950	8/ 2	13
1978	399,000	7/18	34,230	7/30	12
1979	322,000***	7/19	87,920	7/29	10
1968-78 Avg.	221,333	7/19	36,965	8/ 2	16

* 1971 and 1977 data deleted due to high water which resulted in atypical migrational timing.
** Escapement past weir only.
*** Preliminary data.

Table 15. Kenai River Sonar Counts, Total Late Russian River Sockeye Salmon Run and Percent of Kenai River Escapement to Enter Russian River, 1968-1979.*

Year	Sockeye Salmon Sonar Count	Total Late Russian River Run**	Percent Kenai River Run to Russian River
1968	88,000	58,900	66.9
1969	53,000	31,170	58.8
1970	68,000	31,000	45.6
1972	335,000	101,050	30.2
1973	368,000	40,590	11.0
1974	157,000	35,360	22.5
1975	143,000	41,050	28.7
1976	381,000	49,120	12.9
1977	757,000	65,940	8.7
1978	399,000	77,090	19.3
1979	322,000***	118,670	36.9
1968-79 Average	274,900	53,127	30.5

* 1971 data deleted due to sonar malfunction.
** Includes escapement past weir, fish spawning below Falls and sport harvest.
*** Preliminary data.

The mean catch per hour during the early run fishery was 0.087. This relatively low catch rate is directly attributed to the early run's rapid migration. The catch rate would have been even lower had the "sanctuary" not been opened.

Late run sockeye salmon began to enter the sport fishery on July 11. Catch rates were, however, exceptionally low averaging only 0.032 sockeye salmon per angler hour through July 17. Weir escapement for this segment of the population totaled only 34 fish, as of this date, and observation indicated few late run fish in the fishery or in Russian River Falls. Similarly, escapements as enumerated by sonar counter in the lower Kenai River were relatively low. These indicators coupled with the relatively low (24,650) 1974 parent year escapement dictated the closure of the Russian River sockeye salmon fishery on July 19.

By July 22 escapement past the Kenai River sonar counter had significantly increased. The Kenai River sockeye salmon sport fishery, which had been closed concomitant with the Russian River fishery, was therefore reopened at 1200 hours on July 22. The escapement past the weir at Lower Russian Lake, however, was only 62 fish as of this date. The minimum goal for the Russian River late run escapement is 30,000. The Russian River was therefore not reopened at this time.

By July 25 less than 200 late run fish had passed the Lower Russian Lake weir although it was known large numbers of fish were in Lower Russian River. Historically, more than 2,500 fish should have been enumerated by this date if the escapement goal was to be met. On July 26 the sockeye salmon which had been holding in Russian River Falls began to move upstream and over 6,000 passed the weir. On July 27, 17,770 fish passed through the weir. The escapement of 17,770 fish in a given day is the highest number of fish passed in a 24 hour period since weirs were first utilized at Russian River in 1969.

The large numbers and rapid movement of the late run required an immediate opening if harvest and angler recreational opportunity were to be maximized. The Russian River was therefore reopened to sockeye salmon fishing at 1200 hours on July 28.

The late run migration through the fishery, Falls and weir continued at an accelerated rate with 12,600 fish past on July 28. The cumulative escapement through July 28, was 36,700 salmon. The minimum escapement goal of 30,000 had therefore been achieved in only 3 days. In an average year only 21.8% of the escapement would have been past by this date.

The rapid migrational rate of the late run, as with the early run, is again attributed to low water conditions. Low water eliminated historic resting areas in Russian River and forced the fish to move from the Kenai River directly to Russian River Falls. This effectively reduced the potential

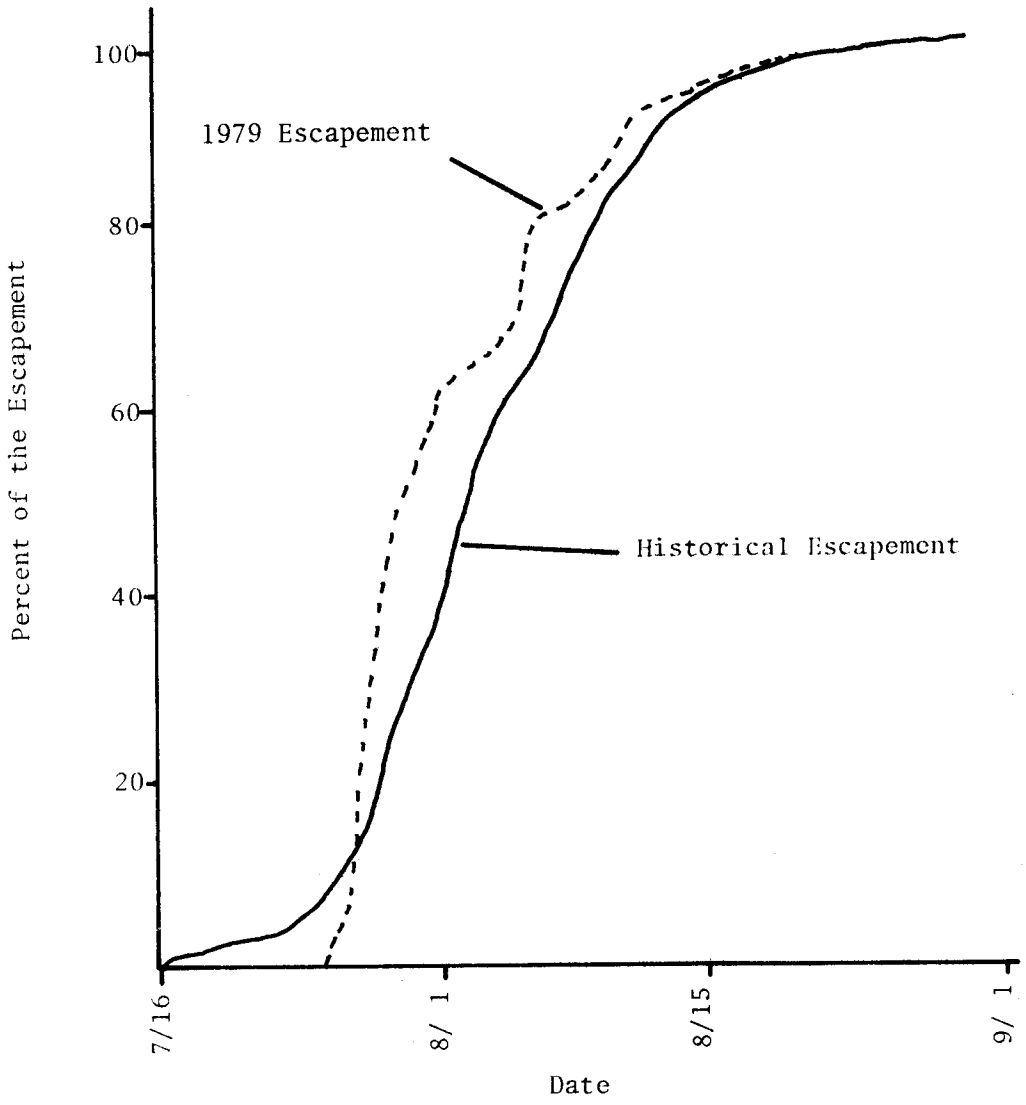


Fig. 4. Migrational Timing of the 1979 Russian River Late Sockeye Salmon Run Compared to Historical Escapement Rates.

recreational harvest which would have been at record levels, had the migrational speed of these late run fish corresponded to historic passage rates. Figure 4 depicts the 1979 late run escapement timing compared to historical passage rates.

By July 31 it was evident that the 1979 late Russian River run would be one of the largest recorded. However, due to accelerated passage rates, the catch in relation to run strength was relatively low. To maximize the harvest and angler opportunity, an approximately 640 m (0.4 mi) area between Russian River Falls and the weir at Lower Russian Lake was opened at 1200 hours August 1. This area remained open until the scheduled Russian River sockeye salmon closure on August 20.

The 1979 late run harvest of 26,830 is the second highest catch recorded for this segment of the population. A record harvest did not occur due to: (1) Limitations placed on vehicular parking by the United States Fish and Wildlife and United States Forest Services and (2) The rapid migration of these fish through Russian River, which limited the time they were available to the sport angler.

Late run sockeye salmon escapement through the Russian River weir was a record 87,920 fish. The total late run return (harvest + weir escapement + fish spawning below the Falls) of 118,650 is 17.4% greater than the previous high return of 101,050 in 1972. The reasons for this exceptional late run return are not definitely known. It is, however, probable that a 6-day commercial fishing closure (July 14-19) in the central district of Cook Inlet significantly reduced the commercial exploitation rate of these stocks, permitting a higher percentage of the run to return to Russian River.

Russian River Fish Pass

The fish passage facility at Russian River Falls was operational for the first time in 1979. The fish pass was designed to permit sockeye salmon unrestricted passage through the Falls during periods of high water. Atypically high discharge rates through Russian River Falls have delayed, and at times totally blocked, migration. Mortality below Russian River Falls has been documented as a result of these delays (Nelson, 1978).

No formal evaluation of the fish pass was conducted in 1979. However, random observations were made throughout the season in an attempt to ascertain the following: (1) Are sockeye salmon attracted to the entrance of the fish pass; (2) if (1) is true, is the fish pass the preferred migrational route as opposed to the falls; and (3) How effective is the fish pass at various water levels?

Discharge rates during the early run migration closely approximated historical flows. Observation indicated fish experienced no difficulty

ascending the Falls at these velocities. Despite average discharge rates, early run sockeye salmon were attracted to and did utilize the facility. The percentage of the run which utilized the fish pass is, however, not known.

It is the opinion of the author that operation of the fish pass during normal water flow was not detrimental to the aesthetics of the area. A large but unknown percentage of the run continued to follow their traditional migratory route through the main body of the Russian River Falls. Observations to date indicate that given a choice, the majority of the run will ascend the falls. Fears that operation of the fish pass during low or normal water will divert the majority of the fish through the tunnel, thus reducing the value of this historic salmon viewing area, appear unfounded.

Discharge rates continued at, or below, historic levels during the first part of the late run. Observations during this period approximated those made during the early run. Late run fish were attracted to and did utilize the fish pass. One, 15 minute observation during the peak of the migration indicated 72 fish exiting the tunnel. If the migration rate for that day were constant, an estimated 6,912 fish would have utilized the fish pass in a 24 hour period. Nonetheless, it appeared the majority of the late run preferred to ascend the falls rather than utilize the fish pass at these water levels.

On August 11 water levels began to rise due to heavy rains in the Upper Russian Lake drainage. By August 17, Russian River discharge had increased to 513 cfs and Rendezvous Creek, which is tributary to Russian River above the falls, contributed an additional 44 cfs. Total volume of water passing through Russian River Falls was therefore 557 cfs. At this discharge rate, the falls are a total barrier to sockeye salmon migration. These conditions were in affect until August 22 when the waters receded to their former level (Figure 5).

Late run sockeye salmon utilized the fish pass during this high water period when Russian River Falls were a total barrier to their migration. Over 1,600 fish were enumerated at the weir during this period and it is assumed they all negotiated the falls via the fish pass.

Age Class Composition

Scale analysis revealed sockeye salmon in their sixth year of life comprised 74.6% of the early Russian River run. Five year fish comprised the remaining 25.4% of the sample. The run was dominated (95.5%) by salmon which reared for 2 years in Upper Russian Lake. The majority of the early run were the progeny of the 1973 escapement.

Early run salmon averaged 598.2 mm (23.5 in) in length. Average lengths of two-and three-ocean fish were 550.1 mm (21.7 in) and 610.8 mm (24.0 in), respectively. The male to female sex ratio was 1:0.8.

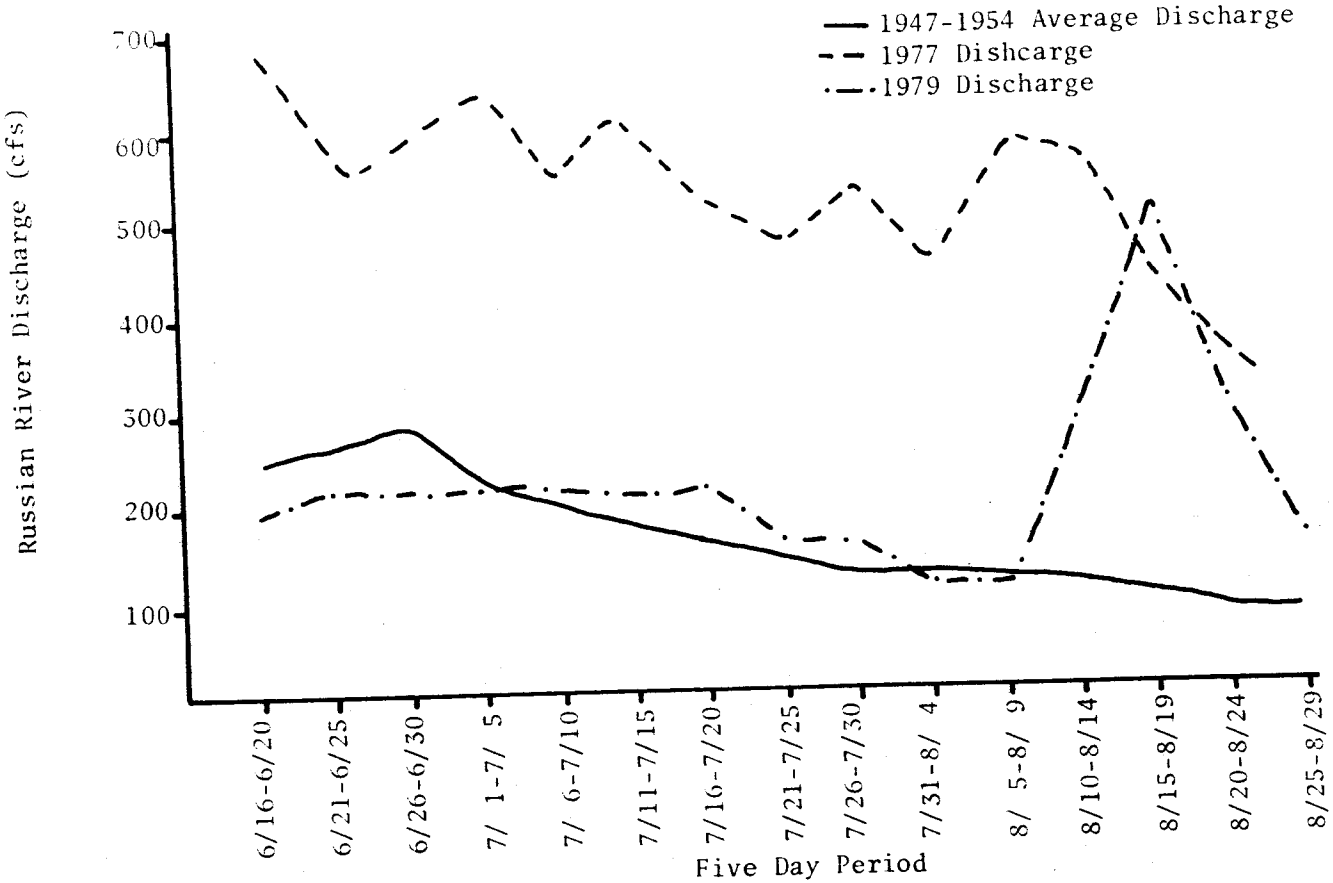


Fig. 5. Mean (eight year) Russian River Discharge Rates by Five Day Average Recorded by United States Geological Survey from 1947 through 1954 Compared to 1977 and 1979 Discharge Rates.

Late run stocks were also dominated by salmon that migrated to the marine environment after 2 years in freshwater (96.4%). The majority of the run (91.2%) spent 2 years in salt water prior to returning to their natal stream. The male to female sex ratio (excluding jacks) was 1:1.3. Late run sockeye salmon averaged 548.0 mm (21.6 in) in length, 50.2 mm (2.0 in) less than the average early run fish. This length differential is related to age structure in that the average early run fish remains in the marine environment for 3 years as opposed to 2 years for the majority of the late run fish. Two-and three-ocean adults averaged 541.6 mm (21.3 in) and 610.3 mm (24.0 in), respectively.

Age class composition of early and late runs and average lengths for respective age classes are presented in Table 16.

Table 17 presents a summary of early and late run sockeye salmon age class data from Russian River since 1970. This table clearly shows the dominance of age class 2.3 in the early run and 2.2 in the late run. The exception to the dominance of age class 2.3 in the early run occurred in 1977 when 60.7% of the run was age class 1.3. The significance of this departure from the historic age structure has been discussed (Nelson, 1978).

The length-frequency of 177 early run fish is presented in Figure 6. This figure indicates the majority of early run fish (70.0%) exceed 590.0 mm (23.2 in). Figure 7 presents the length-frequency of the late run sample. The majority of the late sample (90.2%) are less than 590 mm (23.2 in). This length differential is again a function of the age structure of the populations in that the average early run fish rears for 3 years in the marine environment as opposed to 2 years for the majority of the late run.

Early Run Return Per Spawner

Numbers of fish produced for each early run fish in the parent (brood) year spawning escapement is presented in Table 18. During the 11-year period 1963-1973 the return per spawning fish in the parent year escapement has averaged 2.5, ranging from 0.2-10.6. The significance of a return of 10.6 fish for each fish in the spawning escapement has been discussed (Nelson, 1979). This author also noted that a large spawning escapement does not necessarily insure a high return rate. The lowest return per spawner (0.2) was produced by one of the largest parent year escapements (21,510).

Return per spawner for the 1973 parent year which returned in 1977, 1978 and 1979 was 1.9. Although this is below the historical average return rate of 2.5, it is above average if the atypically high return of 10.6 fish per spawner is not considered.

Foerster (1968) indicates that no matter what level of escapement is compared, the variations in production, as indicated by the numbers of adult fish returning, are quite marked. In the Fraser River, return per

Table 16. Age Class Composition, Sample Size, Parent Year and Average Length of Adult Sockeye Salmon in Respective Age Classes For Early and Late Run Russian River Escapements, 1979.

Age Class	Estimated No. In Escapement	Sample Size	Estimated Percent of Escapement	Parent Year	Average Length (mm)*	S.D.**
Early Run						
1.3	887	8	4.5	1974	613.1	20.0
2.2	4,117	37	20.9	1974	550.1	20.9
2.3	14,696	132	74.6	1973	610.7	23.3
						****
Combined	19,700	177	100.0		598.2****	33.5
Late Run						
1.2	1,815	10	2.1	1975	530.5	29.0
1.3	346	2	0.4	1974	605.0	28.3
2.2	76,244	417	88.2	1974	541.9	25.1
2.3	7,088	39	8.2	1973	610.6	23.9
3.2	778	4	0.9	1973	546.3	25.9
3.3	173	1	0.2	1972	610.0	
						****
Combined	86,444***	473	100.0		548.0****	32.0

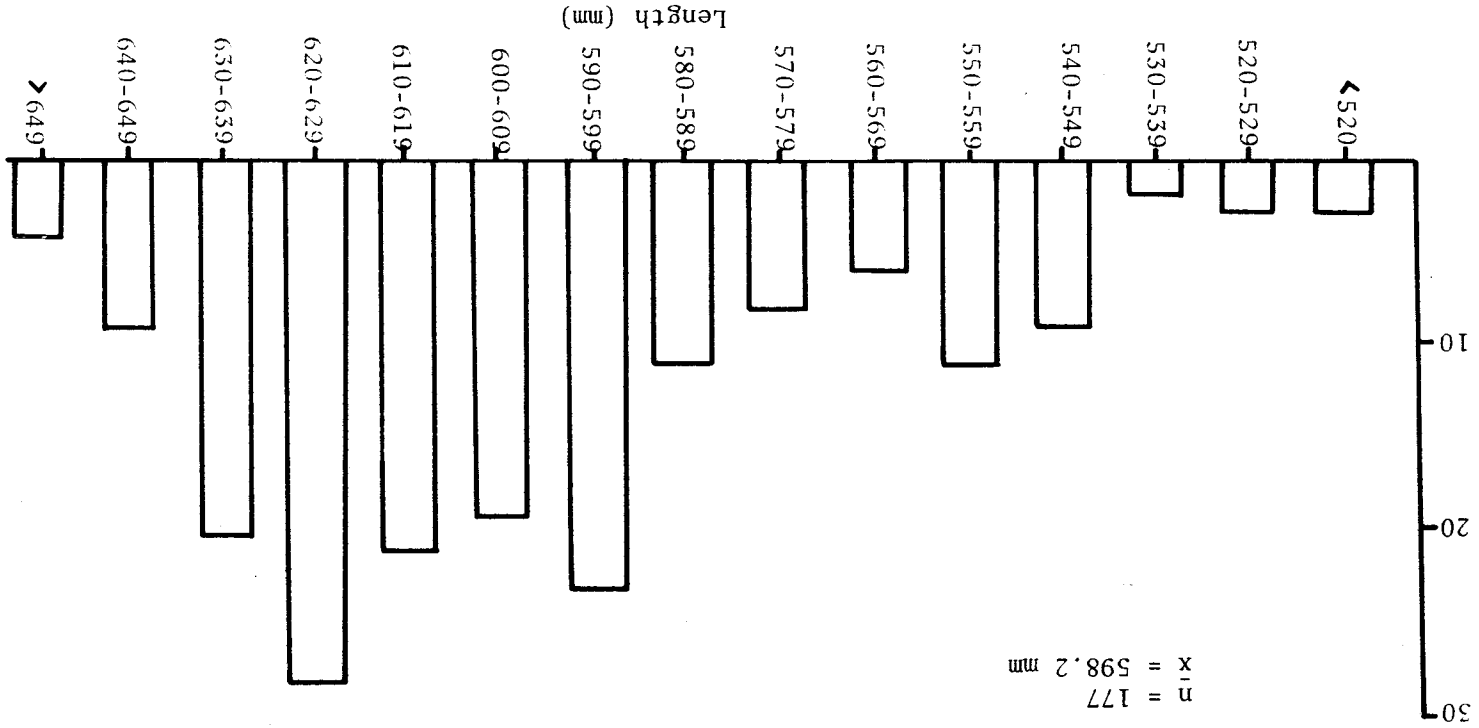
* Length is from mid-eye to fork of tail.
** Standard Deviation.
*** Excludes 1,476 jacks.
**** Average length and standard deviation calculated from the total sample.

Table 17. Age Class Composition by Percent of Early and Late Run Adult Russian River Sockeye Salmon Escapements, 1970-1979.

Year	Age Class 1.2	1.3	1.4	2.2	2.3	2.4	3.2	3.3
				Early Run				
1970	0.4			8.9	87.1	3.6		
1971	1.1	3.2		6.4	89.3			
1972	3.0	38.0		8.4	50.0	0.6		
1973				No Data Available				
1974	0.5	32.0		3.4	63.6	0.5		
1975	0.4	1.8	0.4	19.7	75.1	0.4	0.9	1.3
1976	16.8	1.5		11.4	61.1		0.8	8.4
1977	1.9	60.7		14.0	23.4			
1978	0.1	3.0		1.6	95.3			
1979		4.5		20.9	74.6			
1970-78 Average*	3.0	17.5	0.1	9.2	68.1	0.7	0.2	1.2
				Late Run				
1970	2.5	2.9		87.3	7.3			
1971	1.9	5.3		61.5	30.3			
1972				No Data Available				
1973				No Data Available				
1974	5.5	9.0		58.6	26.9			
1975	5.4	2.9		65.9	23.9		1.9	
1976	10.9	4.3		59.6	23.6		1.0	0.6
1977	6.6	7.7		72.6	13.1			
1978	0.9	5.3		58.8	35.0			
1979	2.1	0.4		88.2	8.2		0.9	0.2
1970-78 Average**	4.8	5.4		66.4	22.9		0.4	0.1

* 1973 deleted from computations. Eight year average.
** 1972 and 1973 deleted from computations. Seven year average.

Fig. 6. Length Frequency of Early Run Russian River Sockeye Salmon Sampled at Lower Russian Lake Weir, 1979.



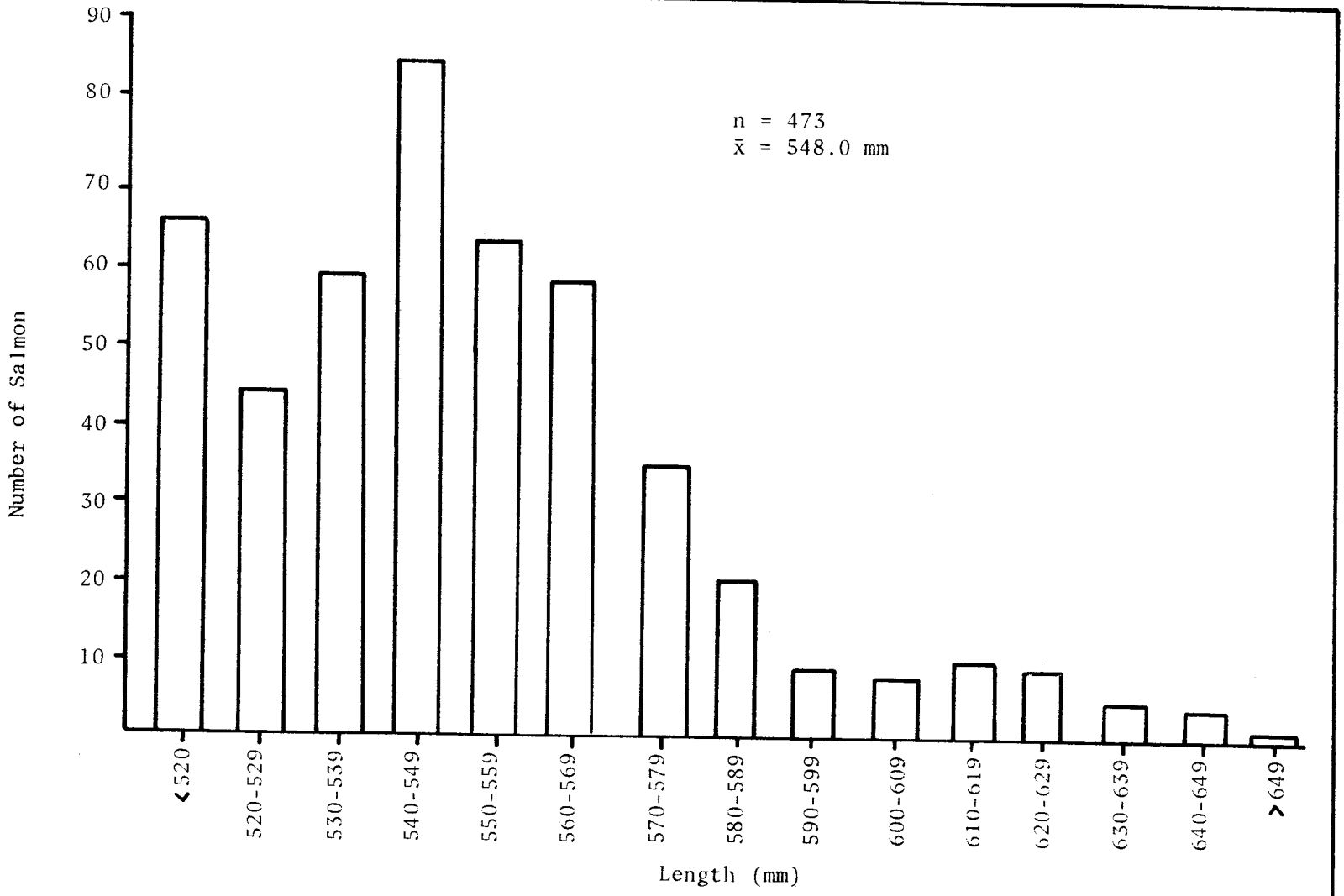


Fig. 7. Length-Frequency of Late Run Russian River Adult Sockeye Salmon Sampled at Lower Russian Lake Weir, 1979.

Table 18. Estimated Production from Known Escapements of Early Run Russian River Sockeye Salmon, 1963-1975.

Brood Year	Escapement	Return* Year(s) 1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	Total	Return Per Female	Return Per Spawner
1963**	14,380	10,870***											10,870	1.5	0.7
1964**	12,700		11,200***										11,200	1.8	0.9
1965**	21,510			4,875***									4,875	0.4	0.2
1966**	16,660			525	7,241	417							8,183	1.0	0.5
1967**	13,710			60	6,640	12,830	98						19,628	2.8	1.4
1968**	9,200				429	5,938	12,459	120					18,946	4.0	2.0
1969**	5,000					675	6,935	5,378	1,520				14,508	5.8	2.9
1970**	5,450						98	1,514	11,198				12,810	5.3	2.3
1971**	2,650							28	2,334	8,534			10,896	8.7	4.1
1972**	9,270								3,038	27,243	68,492		98,773	26.6	10.6
1973**	13,120									693	3,306	20,963	24,962	3.8	1.9
1974	13,150										72	7,137			
Total	136,800	10,870	11,200	5,460	14,310	19,860	19,590	7,040	18,090	36,470	71,870	28,100	235,651		
Average	11,400												21,422	5.6	2.5

* Return equals sport harvest plus escapement. A negligible commercial harvest is assumed.
** Assumes a male to female sex ratio of 1:1.0.
*** Age structure of the run not determined during these years. Assumes run was age class 2.3 or six-year fish.

spawner has ranged from 2.2 to 13.0, averaging 5.4 from 1938 to 1954. Foerster concludes that most of the variability in production occurs during the fresh water developmental stages. Although not definitive at this time, available data does suggest early run Russian River production may be related to environmental conditions during egg incubation in Upper Russian Creek.

Egg Deposition

Egg sampling to determine actual egg deposition and survival of early run eggs in Upper Russian Creek in 1979 was not conducted. Heavy rains beginning in mid-August and continuing through October precluded this activity by raising the stream to atypically high levels.

Egg density and survival estimates in Upper Russian Creek as obtained by hydraulic sampler from 1972-1978 are presented in Table 19. This table indicates high egg densities were recorded in both 1972 and 1973. Data therefore indicate that high egg densities in Upper Russian Creek during these years yielded higher than average returns. If this relationship is true, the 1980 return should also be above average as egg density in 1974 was the highest recorded.

Early run escapements from 1975-1977 averaged 12,137. Egg density for these 3 years, however, averaged only 54.1 eggs/M^2. The 1975 escapement was one of the lowest recorded. Nelson (1978) indicated observation in 1976 and 1977 suggested high water may have washed many eggs from the gravel during these years. As noted earlier in this report, high numbers of spawners do not necessarily produce large returns. Egg density data to date suggests a more consistent relationship between number of eggs in the gravel and return rate. This further suggests that the environmental conditions in Upper Russian Creek during egg incubation exert a greater influence on numbers of returning adults than do actual numbers of early run fish in the parent year escapement.

Fecundity Investigations

Fecundity investigations initiated in 1973 were continued during the 1979 season. Results are presented in Table 20. Fecundity of early run salmon ranged from 3,242 to 4,940 eggs/female. The average weight of females sampled was 2.49 kg (5.49 lb) and the average length was 577.0 mm (22.7 in). These fish averaged 1,543 eggs/kg of body weight and 6.7 eggs/mm of body length. Late run sockeye salmon averaged 3,313.6 eggs/female with a range of 2,741-4,478. Average weight and length of late run fish sampled was 2.20 kg (4.86 lb) and 542.0 mm (21.3 in), respectively. These fish averaged 1,504 eggs/kg of body weight and 6.1 eggs/mm of body length. Table 21 compares these data with results from prior investigations.

Table 19. Early Run Russian River Sockeye Salmon Egg Densities in Upper Russian Creek Compared to Known Adult Returns, 1972-1978.

Year	Total Eggs Dug	Average Eggs Per Point	Percent Survival	Density (Egg/M^2)	Adult Return
1972	3,790	75.8	81.1	407.8	98,773
1973	2,967	59.3	93.0	319.6	24,962
1974	8,229	84.0	64.2	455.6	
1975	605	6.2	84.3	33.3	
1976*	901	12.7	91.6	61.3	
1977*	981	12.6	55.0	67.7	
1978*	4,415	48.0	87.6	226.1	

* These data are comparable. These 3 years may not be comparable to prior years due to revised methods of estimating egg densities.

Table 20. Fecundity of Early and Late Run Russian River Sockeye Salmon as Determined by Sampling at Lower Russian Lake Weir, 1979.

Sample Number	Weight kg (lb)	Length (mm)	Number of Eggs		
			Right Skein	Left Skein	Combined
		Early Run			
1	2.33 (5.13)	560	1,771	1,793	3,564
2	3.17 (7.00)	630	2,075	2,507	4,582
3	3.12 (6.87)	620	2,359	2,581	4,940
4	2.43 (5.37)	555	1,635	1,891	3,526
5	2.49 (5.50)	555	1,608	1,791	3,399
6	2.61 (5.75)	595	1,817	2,068	3,885
7	2.04 (4.50)	550	1,503	1,843	3,346
8	2.61 (5.75)	590	1,703	1,891	3,594
9	2.38 (5.25)	580	2,104	2,243	4,347
10	1.70 (3.75)	535	1,498	1,744	3,242
Average	2.49 (5.49)	577.0	1,807.3	2,035.2	3,842.5
		Late Run			
1	3.29 (7.25)	570	2,066	2,412	4,478
2	1.70 (3.75)	500	1,582	1,622	3,204
3	1.93 (4.25)	535	1,232	1,509	2,741
4	2.49 (5.50)	575	1,549	1,851	3,400
5	2.15 (4.75)	530	1,414	1,552	2,966
6	2.04 (4.50)	530	1,367	1,395	2,762
7	2.27 (5.00)	540	1,530	1,780	3,310
8	2.04 (4.50)	550	1,356	1,455	2,811
9	2.04 (4.50)	540	1,639	1,823	3,462
10	2.09 (4.62)	550	1,858	2,144	4,002
Average	2.20 (4.86)	542.0	1,559.3	1,754.3	3,313.6

Table 21. A Comparison of Fecundity Data Collected at Lower Russian Lake Weir During Early and Late Run Russian River Sockeye Salmon Migrations, 1973-1979.

Year	Average Fecundity	Average Length (mm)	Average Weight (kg)	Eggs/ Kilogram	Eggs/ Millimeter
			Early Run		
1973	4,630	627.0	2.968	1,560	7.4
1974	3,569	603.0	2.603	1,371	5.9
1975	3,952	600.0	2.540	1,556	6.6
1976	3,668	596.0	2.608	1,406	6.1
1977	4,313	602.7	2.852	1,512	7.1
1978	3,815	608.1	2.821	1,352	6.3
1979	3,842	577.0	2.490	1,543	6.7
			Late Run		
1973	3,190	569.0	2.187	1,459	5.6
1974	3,261	558.0	2.301	1,417	5.8
1975	3,555	555.0	2.257	1,575	6.4
1976	3,491	587.0	2.533	1,378	5.9
1977	3,302	567.1	2.438	1,354	5.8
1978	2,865	584.0	2.672	1,072	4.9
1979	3,314	542.0	2.204	1,504	6.1

Table 22. Climatological and Hydrological Observations by Six-Day Periods Recorded at Lower Russian Lake Weir, May 8-August 31, 1979.

Period	Water Temperature*		Air Temperature*		Discharge**	Rainfall
	Max °C	Min °C	Max °C	Min °C	(cfs)	(mm)***
May 8-13	7.0	4.7	12.9	-1.7	302.3	
May 14-19	6.8	5.0	12.1	-0.3	281.7	
May 20-25	7.6	5.6	12.0	-0.1	216.2	
May 26-31	10.3	7.8	20.3	0.8	245.0	
June 1-6	10.1	7.6	16.5	2.9	275.2	
June 7-12	10.7	8.9	18.1	2.2	216.2	
June 13-18	11.1	8.5	18.6	1.7	194.5	
June 19-24	11.2	10.0	17.4	5.4	195.8	
June 25-30	10.7	9.5	15.1	4.8	229.6	
July 1-6	12.8	11.5	22.2	7.6	225.2	
July 7-12	13.0	12.0	18.1	7.8	229.9	
July 13-18	12.9	12.2	17.5	8.7	243.0	
July 19-24	14.8	10.6	18.4	8.6	178.3	
July 25-30	13.3	12.3	19.3	7.6	172.7	3.0
July 31-August 5	14.5	13.9	19.5	9.3	122.9	10.8
August 6-11	14.1	12.9	16.6	8.8	195.3	17.3
August 12-17	12.3	11.6	14.9	9.3	370.5	44.0
August 18-23	11.9	11.0	17.2	4.8	388.1	4.4
August 24-29	13.3	11.7	19.8	4.9	194.7	0.0

* Air and water temperature for the respective periods are the average of the daily recordings.
** Russian River discharge only. Excludes Rendezvous Creek discharge.
*** Rainfall for each period is the cumulative total of the daily recordings.

Table 21 indicates the average early run female sampled in 1979 was smaller (both length and weight) than those in prior years. Average egg content, eggs/mm and egg/kg are, however, comparable to historic data for this run. Fish utilized for the late run show similar trends. Average egg content, eggs/kg and eggs/mm are comparable to prior data. Average length of late run fish sampled was less than prior years and the average weight was lower only in 1973. Reason(s) for the relatively small early and late run fish sampled in 1979 are not known.

Climatological Observations

Climatological data recorded at Lower Russian Lake are grouped by 6-day period to facilitate analysis (Table 22). No correlation was found between air and water temperature and adult sockeye salmon migration. The relationship between smolt out-migration and water temperature has been discussed earlier in this report. Due to an error by weir personnel in reading the rain gauge, accurate percipitation data are available only from July 25-August 29. Air and water temperatures during the 1979 season are comparable to prior years data. The affect of high Russian River flows on the latter segment of the late run's migration has been discussed earlier in this report.

LITERATURE CITED

Burgner, R.L. 1958. A study of the fluctuations in abundance, growth and survival in the early life stages of the red salmon, Oncorhynchus nerka (Walbaum), of the Wood River lakes, Bristol Bay, Alaska, Ph.D. Thesis, Univ. Washington, Seattle, 200 p.

Engel, L.J. 1965. Inventory and cataloging of the sport fish and sport fish waters of the Kenai Peninsula, Cook Inlet-Prince William Sound areas. Alaska Dept. of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1964-1965, Project F-5-R-6, 6(7-A): 111-127.

_____. 1966. Inventory and cataloging of the sport fish and sport fish waters on the Kenai Peninsula, Cook Inlet-Prince William Sound areas. Alaska Dept. of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1965-1966. Project F-5-R-7, 7(7-A): 59-78.

_____. 1967. Inventory and cataloging of the sport fish and sport fish waters of the Kenai Peninsula, Cook Inlet-Prince William Sound areas. Alaska Dept. of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1966-1967. Project F-5-R-8, 8(7-A): 73-81.

_____. 1968. Inventory and cataloging of the sport fish and sport fish waters of the Kenai Peninsula, Cook Inlet-Prince William Sound areas. Alaska Dept. of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1967-1968. Project F-5-R-9, 9(7-A): 95-116.

_____. 1969. Inventory and cataloging of Kenai Peninsula Cook Inlet and Prince William Sound drainage and fish stocks. Alaska Dept. of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1968-1969. Project F-9-1, 10(7-A): 111-130.

_____. 1970. Studies on the Russian River red salmon sport fishery. Alaska Dept. of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1969-1970. Project F-9-2, 11(G-II-G): 79-89.

_____. 1971. Studies on the Russian River red salmon sport fishery. Alaska Dept. of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1970-1971. Project F-9-3, 12(G-II-G): 79-89.

_____. 1972. Studies on the Russian River red salmon sport fishery. Alaska Dept. of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1971-1972. Project F-9-4, 13(G-II-G): 1-14.

Foerster, R.E. 1968. The sockeye salmon, Oncorhynchus nerka (Walbaum). Fish. Res. Bd. of Canada, Bull, 162. 422 pp.

Lawler, R.R. 1963. Inventory and cataloging of the sport fish and sport fish waters on the Kenai Peninsula and Prince William Sound. Alaska Dept. of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1963-1964. Project F-5-R-5, 5(6-A): 113-122.

_____. 1964. Inventory and cataloging of the sport fish and sport fish waters on the Kenai Peninsula and Prince William Sound. Alaska Dept. of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1964-1965. Project F-6-R-6, 6(7-A):

Nelson, D.C. 1973. Studies on Russian River red salmon sport fishery. Alaska Dept. of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1972-1973. Project F-9-5, 14(G-II-G): 1-26.

_____. 1974. Studies on the Russian River red salmon sport fishery. Alaska Dept. of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1973-1974. Project F-9-5, 15(G-II-G): 21-48.

_____. 1975. Russian River red salmon study. Alaska Dept. of Fish and Game. Anadromous Fish Studies, Annual Report of Progress, 1974-1975. Project AFS 44, 16(AFS-44-1): 1-41.

_____. 1976. Russian River red salmon study. Alaska Dept. of Fish and Game. Anadromous Fish Studies, Annual Report of Progress, 1975-1976. Project AFS 44, 17(AFS-44-2): 1-54.

_____. 1977. Russian River red salmon study. Alaska Dept. of Fish and Game. Anadromous Fish Studies, Annual Report of Progress, 1976-1977. Project AFS 44, 18(AFS-44-3): 1-54.

_____. 1978. Russian River sockeye salmon study. Alaska Dept. of Fish and Game. Anadromous Fish Studies, Annual Report of Progress, 1977-1978. Project AFS 44, 19(AFS-44-4): 1-57.

_____. 1979. Russian River sockeye salmon study. Alaska Dept. of Fish and Game. Anadromous Fish Studies, Annual Report of Progress, 1978-1979. Project AFS 44, 20(AFS-44-5): 1-60.

Neuhold J.M. and Lu, K.H. 1957. Creel census method. Utah Dept. of Fish and Game Publication No. 8. 36 pp.

Prepared by:

David C. Nelson

Approved by:

Rupert E. Andrews, Director
Division of Sport Fish

Mark C. Warner, Ph.D
Sport Fish Research Chief